Mike Alkin & Adam Rodman: Can a Nuclear Renaissance Solve the Global Energy Crisis?

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Erik: Joining me now are Mike Alkin, Principal and Chief Investment Officer for Sachem Cove Partners, and Adam Rodman, who is Founder and Chief Investment Officer for Segra Capital Management. Why don't we start with Mike, give us a quick perspective on you guys both run funds in the nuclear space. What specifically do you do Mike? And we can contrast that with Adam in just a moment so our listeners understand how you guys both come at this.

Mike: Sure. Thanks Erik. So we are in the hedge fund business for over 25 years and back in 2015 started to look at an opportunity that I thought there might be a disconnect between the narrative and the facts in nuclear power and uranium. And so after a couple of years of doing deep dive due diligence on the industry, started the fund to express the view to invest in the nuclear fuel cycle. And that could be investing in physical uranium, proxy for physical uranium, it could be investing in the uranium mining equities, or private investments within the uranium space which we also do. So that's what we do. It's 24/7, the nuclear fuel cycle.

Erik: Okay, so Mike's business is entirely about the nuclear fuel cycle. Adam Rodman, how do you look at this opportunity space of investing in nuclear?

Adam: Yeah, sure. I'm not as tenured as Mike but about 15 years in the hedge fund business. Founded Segra Capital as a generalist fund always focused on, you know, kind of parts of the global markets that we thought were underappreciated or undervalued, and not dissimilar from Mike, around, you know, four or five years ago thought we were getting to a critical point in nuclear powers role and I guess take the energy transition and pivoted our fund to focus more or less exclusively on nuclear and nuclear-related opportunities. We've since kind of grown the offering under the Segra Capital umbrella. So we run a long-biased, but long-short hedge fund that looks at all things nuclear, including the nuclear fuel cycle, as Mike pointed out, and we also have a series of private funds dedicated to the space in addition to being in the midst of launching a commingled venture and growth equity fund looking at advanced nuclear and all related opportunities.

Erik: I want to start by describing what our listeners have already heard from several other guests we've had in recent weeks, and that is that the world has entered an energy crisis which most people don't understand. And it is described by essentially governments around the world have gotten on this climate agenda. And that may be a very good thing for the world in many

ways. But what they've done is they've tried to phase out fossil fuels before phasing in the replacement and the result is that we have insufficient investment in exploration and production of oil and natural gas. And I think what it's set us up for is the inability, it's impossible now in my opinion for the world to return to pre-pandemic normal economic conditions, because we simply don't have the energy capacity, the energy supply needed in order to meet demand for a true return to normal and we have energy resources that are continuing to deplete. Saudi Arabia has shown us their cards and admitted that they don't have much spare capacity left. And it just seems like a very clear situation here that there is no good solution to this anytime soon and we're headed into an energy crisis where Europe is not at all isolated. There just happened to be showing the earliest symptoms of something that I think will spread around the whole world and that's the reason I think it's so important to revisit the question of whether a nuclear renaissance could completely change the longer term outlook. I don't want to dive into an interview based on that assumption on my part without making sure you guys are on the same page. So you obviously follow energy markets generally. Would you agree that we have a formative global energy crisis? Is it not as bad as I think is it worse than I think? And does it make sense to be thinking about how nuclear is going to play into the solution to that problem? Why don't we start with Mike Alkin.

Mike: Thanks, Erik. I do. I do believe we have an energy crisis and I think, look, does everyone or do most people want cleaner air? More carbon free generation? Yes, of course. I think most people would say that they do. But I think you also have to deal with technological realities. Energy transitions take many many decades. They're not willed by the world being scolded by a teenager at a conference and being told how we're irresponsible. That's fine. We get the message that the world can use clean energy, but you have to work with what you have. And you know, the last several years you've seen. If you look back Has decade or so when you look at capital investment in the fossil fuel space, it has imploded, right? It's not worth the risk. It's not worth the public pounding that companies will take by investing in it. And as a result, like anything, it's supply-demand. When you under invest, you're ultimately going to have to pay the piper. And you've seen it in oil and gas, you've seen it in coal. And they will be a part of of the energy mix for decades, right? Can we reduce dependency over time? Yeah, perhaps we can. And that can come from other sources. But the world's transition to public policy that is, you know, people want... They can't put wind and solar out fast enough. And the reality is when you look at capacity factors for solar and wind of 25 and 35%, versus say nuclear energy in the 90s and other baseload sources, whether natural gas recall, there's no comparison, right? So you can't eliminate these other sources. But the world has tried and has shamed fossil fuel companies into doing what they need to do, which is to go explore and they go produce and to go permit and license and get everything so that it can keep pace with the needs of the world to run on baseload power. And that's not happened so yes, I think that has driven a crisis. And I also think the geopolitical winds have been misaligned for a number of years, right? Globalization of the past 30 years has created a false sense of security, energy security. And I think you're seeing that come home to roost now.

Erik: Adam how do you see it? Are we in an energy crisis?

Adam: Well you know Mike, I think summed it up there pretty well. I generally agree. I mean, at least speaking from our investment process, you know, we we're big believers in incentives and the capital cycles that are driven by incentives. And I think echoing what Mike said, we unfortunately have a pretty big misalignment now. And I would agree that because of delayed CapEx in some energy industries, or outright banned CapEx and others, the world is in a precarious position over the next decade or so.

So we are in agreement that the world is facing an energy crisis, or at least a precarious position. We need to figure out solutions to that I think it's pretty clear that the reason, the many reasons that nuclear energy would have been a great solution if we had really focused on it 10 or 20 years ago, are obvious to us. But it seems like perceptions around safety are the biggest thing that prevents this industry from really having the position I think it should have in the world. So let's start with a review of what the real facts are in safety. People perceive nuclear energy is being dangerous, when in fact, there are many statistics that say that it's the safest kind of power that we have. And Mike, I know you've got some statistics on this? Tell us a little bit about what the statistics are in terms of nuclear energy and its safety and cleanliness compared to other energy sources?

Mike: Erik, you bring up a good point, right? We often say when we look at nuclear power, that it's an example of how people let the facts. They don't let the facts get in the way of a good narrative right. So the narrative is that nuclear is unsafe, that you everyone invokes Three Mile Island and Chernobyl and Fukushima. Even though the combined deaths of those you could you know, we're almost you can't even identify them. There's less than 100 deaths from those you have those in refinery accidents and chemical plant accidents around the road coal plants. You have millions of people who are dying from the CO2 coming out from there. But when you look at those, when you look at deaths from energy related accidents per unit of electricity, that's what people are worried about, right? You, you're looking at nuclear, you have 90 deaths per 1000 terawatt hours. Cail is 100,000 deaths per terawatt hour, oil 36,000, Solar 440, Wind 150. You'll notice that nuclear is at the bottom of that list. So you know, you look at this and you could look at it on any metric. And you could look at it in multiple, and multiple, multiple sources. Nuclear power is the safest form of electricity generation. And it's the math wether people want to ignore the math right? They let the narrative get away the facts, but that is those are the facts.

So whether it was the you know, the reactor core meltdown at Chernobyl or Fukushima. Again, it was the people on site putting the fire out. It was a handful of people in Chernobyl didn't even have a containment dome which it has now. You know, you think about this, whether it's the oil and gas industry, the chemical industry, the airline industry, 100 years of flying, accidents do happen, but you study, you learn, you improve and that's happened in nuclear. You had a few of them but it creates hysteria. But the numbers would bear that. That's what it is. It's hysteria. It's not based on facts. Adam do you have a different view on that or...

Adam: I agree, I agree with your points. Look, I think to summarize, as with everything, there's a great fear of what we don't understand. And there have been many interests against nuclear, given its many positive attributes. And the very negative consequences for other

energy generating sources were to be mass adopted in the way, Erik and maybe you laid out in your original question. So it's not to be conspiratorial about it or to bring up the many kinds of marketing headwinds and lobbying headwinds that the that the industry has faced. But it's to say that it's an easy target. And when you bring up things like radiation and waste, which are these highly generalized topics, not to mention widely misunderstood, they become easy, easy targets, to create fear. And to the extent that we have time to walk through it today on the podcast, it would be good to contextualize some of these fears versus maybe the benefits that the world would get if we could move past that.

Erik: Well, I'm all for that. And let's dive right into it. Because I think it's easy to take the death statistics that Mike cited and say, hey look, lower death statistics. It's got to be better, right? But let's play devil's advocate here. Because an anti-nuclear activist would say, wait a minute, wait a minute, you're not really looking at all of the considerations when you cite only the direct deaths from nuclear accidents. That doesn't consider the nuclear weapons proliferation risk, which I assure you lots of people perceive to exist, whether and to what extent it really exists, I really want to dive into this conversation. But let me play devil's advocate here. The perception is that anytime you have a nuclear power plant, that nuclear reactor could be used in order to breed weapons grade fissionable materials for making nuclear bombs with and although a lot of nuclear power plants don't have the design that's creating those byproducts of those things, the argument that's made is look, the amount of work it would take an educated scientist to go and produce weapons grade plutonium on his own, versus the amount of work it would take to modify a nuclear power plant in order for it to create those things. Once they've got the the reaction going. They've got the nuclear power plant. Smart guys know how to modify it in order to create weapons grade fissionable materials, I assure you, regardless of the facts, that's the perception in the anti-nuclear camp is any reactor of any design, it's got this risk that it adds to nuclear proliferation. If you allow these things to exist all over the world, then it's going to result in terrorists having atomic bombs sooner or later. Is there any truth to that? And if not, why not?

Mike: So Erik, civil nuclear power has not been the cause or route really to any nuclear weapons in any country that has nuclear weapons, right? There's no uranium traded for electricity production that's ever been diverted for military use. So if you look at the nuclear weapons program, right, they take a look at North Korea, they don't have nuclear power. No country is without Uranium, Uranium is plentiful. And we can get into that too, when you talk about the economics of this. Uranium is ubiquitous. It you know, we, I won't, I won't digress here. But uranium is abundant in the earth. Uranium is available, it's economic uranium that matters. But you know, it takes what five tonnes of natural uranium required to produce a nuclear weapon. And so, you know, if cost was no object, you know, you can recover it from many different places. But when you know, you're talking about plutonium, right, it's produced in the reactor core from a proportion of the uranium fuel, and it's contained in spent fuel elements, which is 60 to 70% PU239, which compared with weapons grade plutonium is more than 93% 239.. So it's not weapons grade plutonium is not produced in commercial power reactors.

It's produced and production reactors operated with these frequent fuel changes, which then produces low burn up material with a high proportion of the PU239. So, it's, it's not what's

coming out of commercial reactors, and in the history of nuclear power, 60 plus years there has been no incident. You know, you go back to nuclear power itself, the generation of its 70-80 or whatever, 1000 tons per year, you know, we'll use pounds right? Different people use different things but if we let's just say, let's round up to an our demand, there's not the industry because our demand numbers we think are much more realistic than what the the industry consultants have, but say a couple 100 million pounds a year. Every ounce of that, every pound of that is accounted for, always and always has been. You know, so if the bad guys wanted to go find this stuff they could because uranium is abundant, but it's more controlled in nuclear power. So, you know, that's kind of my view on it. We've just not had an incident in it. I know, people like to fearmonger on that. But it just doesn't, it hasn't happened. And we don't, you know, we think the recipe for that to happen is unbelievably complicated for that to occur. I mean, it might make sense in a Robert Ludlum novel or something like that but we just haven't seen it.

Erik: Well, and I think, unfortunately, that what's in novels is probably as relevant as factual reality, because we're talking about an incredibly emotionally charged political issue here. And they're reading, you know, they're watching movies with Jane Fonda. They're not listening to guys like you on podcasts right now. And yet, we've got to get to a point somehow, where I don't think you can get through the energy crisis that's coming until the general public goes through a change of understanding where they say, okay, maybe there's a really big problem with nuclear meltdowns and nuclear weapons, but the new generation to the current generation of what's being proposed doesn't increase those risks. Is there a an argument that we can say those things really are contained or is it kind of like well sort of contained?

Adam: Can I just jump in with one quick point? I mean, because if it's about basics, kind of versus what's in the novel, most people think that nuclear fuel is essentially the same thing that goes into a nuclear bomb. We have found over time that that when polled, and I think to the heart of your question, many do confuse the two. But I think the misunderstanding between a 5% enrichment level for a reactor versus 15 times that amount for a nuclear weapon yeah oh yeah exactly sorry, my math is off there level for a bomb is not 15 times sorry, about that almost 20 times. It's a nonlinear process. Right? It's exponential to reach that level of enrichment increase for weapons grade enrichment. The point is that it's really about enrichment technology that is linked to proliferation risk, and not operating a civil nuclear reactor as Mike pointed out in the history, there has never been a linkage between the two. And that's not because it just hasn't happened yet. That a country who has a reactor, a nuclear reactor, decided not to make a bomb. That's incorrect, and it should be kind of stamped out unequivocally. The reason is, because it's really the fuel cycle and enrichment capability. That is the deciding factor. And if anything, when a country chooses to adopt and deploy nuclear power, they come under the regulatory scrutiny of international watchdogs that watch every single piece of the uranium fuel cycle in a way that is much, much more transparent and scrutinizable than if you didn't have a reactor. So that if you are a country with a civil nuclear power plant, it is infinitely more difficult to actually create a nuclear weapon. And if you didn't have a civil nuclear plant, and you just decided to go after that, that military option on your own. And so I guess there's two points 5% and 90% enrichment is not linear. And it is all about enrichment technology, not about whether you have a nuclear reactor or nuclear generating power station. And the second point is that if

you are a country that chooses to adopt nuclear power, you open yourself up to regulatory oversight, that decreases the proliferation odds.

Erik: Okay, so it sounds like both of you agree that with respect to the widely held belief that any country that's in possession of an operating civil nuclear power plant could use it to create weapons grade plutonium. Basically, you're both agreeing that that's a myth and in reality, if you're concerned about that risk, you ought to be watching whether or not that country is trying to buy the wrong kind of centrifuge or whatever the actual technology is that leads to that high enrichment. It's not the same civil reactor that's going to get them there in terms of possessing the magic, the secret sauce to make the atomic bomb with. That's just a myth is what you're saying, is that right?

Mike: Yeah, I mean, right you're it's about the enrichment levels, it's about enriching it from you know, 3.5 to 5% for civil nuclear power and it has to be enriched to 90%. That's not coming out of the plant. So it's got to go through that whole enrichment process. We think about, you know, Iran, right? They have enrichment underground. So that's your you're trying to these things are known. You know, when we think about nuclear, we think about, what are the things that people were worried about? See, they're worried about proliferation? Well, like Adam said, you know, everything is, is ticked and tied. IAEA monitors everything, whether it's NRC, IAEA, every pound of this stuff, it's known where it is. So it's very, it's a very safe, secure supply chain if you will, or chain of command. And then you look at it on the on the same thing on the on the nuclear fuel on the spent fuel, right, that's another area of hysteria that people get, get all caught up in when the reality is, it is safely stored on site in cooling ponds. It's then put into steel and concrete reinforced casks, it's under armed guard. It's a contained, it's a contained source of waste. Unlike other sources that you take break down solar panels after 20 years, you throw them into the electronics, waste stream, and you've got cadmium, chromium, nickel, lead, you name it that's just sitting out there completely exposed to the elements. So those are some things that are just common misunderstandings. Is there plutonium as part of commercial nuclear power? Yes but then you gotta get it enriched. And you don't just go buy centrifuges, right? That's, the bad guys aren't just coming up with centrifuges and enriching. So it's just not. It's a very, very complicated thing to do. And it's 60 years. That's a pretty good track record of nothing having happened. But it sounds great for the fear mongering, I don't mean you Erik, but others who want to who have who don't want nuclear power to thrive or survive?

Erik: Well, I think it's for anyone who does believe in the future of nuclear power, we've got to understand the mission ahead of us is not about facts. It's about a perception that has to be overcome. And I think we have the opportunity because the world is about to experience so much pain, over a lack of access to energy, that attitudes will be ripe to change. And the question is, how to get the right message to the right people.

Mike: So to me, that's a great point. So you know, you think about you look at some headlines, I go back to November of 2018. Headlines, major newspapers, magazines, France to close 14 reactors by 2035. The fate of the UK is nuclear plants in doubt over aging infrastructure was 2019. We go back to South Korea, powering down its nuclear energy industry in 2017.

When Adam and I were starting our funds, those were all the headlines, right? So that's the narrative. And fast forward to today, the UK is putting nuclear power at the heart of their net zero strategy. The French are building 14 New Reactors, they're doubling down with a $35 billion commitment. South Korea has just done a 180. Japan is now restarting reactors, because the energy crisis is forcing them to look at the facts. Right. So the narrative is being trumped by the facts, which hasn't happened in a very long time in a nuclear power space.

Adam: Yeah, I was gonna pile on with two other things. Yeah, I would just say take a look at the polling data in Europe, which probably would have been the most kind of anti-nuclear block, if you could pin one globally, and look at kind of northern European countries sentiment on nuclear approval, disapproval, and neutral over time, as an example for how, you know, I think the cats out of the bag in terms of the sentiment shift. And then I would also, you know, just say that, to Mike's point about the government policy, it's, we like to say that your energy policy shifts are really like a tanker ship. Right? And they create these very long cycles that don't get reversed. You know, it's honestly why Fukushima created now you know, more than a decade's long move away from the technology that's just now reversing. We can get into it. But I think from our vantage point, especially working with injured government panels, politicians, the companies in the advanced nuclear space and the leading industry groups related to it, that the government policy, which is already in motion, you know, is too far along to kind of pull back the other way. So I think that while it might be not be the most kumbaya headline, versus say renewables, still, the tectonic plates have shifted, and I think that we will enjoy. Certainly versus what was expected a strong growth period of the industry for the next decade.

Erik: Let's move on then to the other major perceived risks, which is meltdown risk. And, you know, in this case, I think there is an argument to be made that the first generation of nuclear reactors, the big Westinghouse reactors including Fukushima. The design was centered on the idea that yeah, there is a failure mode called a meltdown that can happen if the cooling pumps stopped circulating coolant. So therefore, you just have to design it so that that can't possibly happen. And it's redundant enough that those cooling pumps can't possibly fail. And they did a pretty darn good job of thinking as hard as they could about redundancy when they designed Fukushima. But even after building, you know, they did anticipate that there could be a tidal wave that hit that plant, they built a wall to deflect it, just in case but it wasn't a big enough wall. And what happened was, the whole place got flooded. My understanding of how that accident actually went down is a lot of that redundancy that guaranteed those pumps would keep running was in underground electrical switching areas that got flooded with sea water. And that was part of what all went down there. So you get an extraordinary act of God kind of event. And sure enough, something that was designed to be completely tolerant of one specific failure turned out not to be. So to me, that begs the question, I would hope by now that we have new designs of nuclear power plants that are not reliant on the pumps absolutely have to keep running no matter what. So maybe we could go through some perspective here on and I don't think we can get into all of the nuclear physics of how these things work, but just at a high level, and in terms of where their failure modes and fault tolerance is, what are the different kinds of nuclear power plants? What are the first ones that were built? Great big, huge facilities built on site in the

1970s. How does that compare with the way that things are being developed now and the way that new plants are being designed now,

Adam: I'll be honest, it's probably difficult and beyond the scope of conversation to walk through every single different design, and what each does differently but by and large, advanced nuclear, you know, what I think broadly, is considered to be Gen four steers away from the light water reactors that even though they've gone through different upgrades and cycles are predominantly based off of the original technology that you mentioned. And by using different coolants, moderators, and broad system designs, many of the issues that you bring up become non issues. Either because the reactor vessel is at atmospheric pressure and so there isn't the there aren't the consequences that come from running a pressurized core and something going wrong, or because the coolants, moderators, etc, all have boiling temperatures that are beyond a meltdown risk, any or all of the above work to address the legacy problems, if you want to call it that with existing nuclear and I'm apologies for kind of generalizing, but there are probably by our accounts, something like 70 or 80, new reactor designs that use a mix of all of the above that I went through, again, different different systems designs using different coolants and different moderators in traditional light water reactors. And again, we can't run through all of them. But the point is, if you if you either operate at atmospheric pressure or you use higher if your core essentially can be run with a higher boiling point, just about everything that you brought up, it becomes a non issue going forward. In addition to the fact that inherent to those systems, you would be able to passively walk away without redundancies that you mentioned, because again, the core can't explode and can't melt down.

Erik: Okay, gentlemen, let me turn this around and propose it as a question. Is it true as of today that the technology that would be used for any new nuclear power plant that might be considered for new construction. You said, there's lots of designs, but let's just say the ones that anybody would seriously consider building a new plant with today? Is it a true statement yet, that this whole scenario where there's a meltdown risk, because the pumps aren't running in the redundancy system that was supposed to keep the pumps running didn't work? You're saying that's totally gone. The way they build things today is just not a factor anymore? Is that right?

Adam: No, sorry I should probably clarify that. That's not right. The world is still building many of the of traditional Gen three and Gen three plus reactors. Albeit with it with many, many say safety improvements to the redundancies and other safety measures that you mentioned. The world is still operating and building those in addition to a new wave of advanced reactors, the first of which should be on grid towards the back half of this decade.

Erik: And where are the examples of projects that are running on this new fourth generation technology that you say is the new way, the good stuff.

Adam: As an American, I'd be excited to say that there is two RDP recipients, TerraPower and Next energy as an example would be Gen four advanced reactors, and it's run by two American companies. And I mentioned them just because they are Gen four reactor designs and because again they've received loans from the US government. But I think New Scale as a

Gen three plus, it's now a public company. But again, it's proving that we can approve a new reactor design with improved safety out of the west. And there are also kind of there are test reactors operating at a commercial scale in in the outside of the Western world to say it politely, which has been part of kind of the technology race that I think the west now finds itself in. We're a little bit behind in deploying them. But luckily, I think the capitalist model will prevail here, given the optimism that we have around advanced nuclear companies in the West specifically.

Erik: Gentlemen, I'd like to move on to the subject of the different kinds of nuclear power plants. What's the difference between boiling water and pressurized water in some of these newer kinds of reactors that are coming into play and how do they address some of these safety concerns that we've discussed. Listeners that's coming up right after this message from our sponsor.

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Erik: Gentlemen, let's return to that question of the differences between the different kinds of reactors without going into the nitty gritty of how the nuclear technology works. Could you just give us a quick description of what's the difference between generation four or what are the primary advantages of it from the perspective of safety and reliability of generation four How's it different from generation three?

Adam: Gen fourth industry, I'll just say is it's kind of done a bad job at concretely drawing lines between what is Gen three, what's a small modular reactor, what's an advanced reactor, and how do they tie into the generations. There's never been a very good clear cut definition but broadly speaking, when you think about light-water reactors, that falls into Gen three, and Gen three plus. New scale, which I mentioned is a small modular reactor company, but that operates off of the light water reactor design. So I think by the strictest letter of the law, it is not advanced nuclear, because it is a light water reactor, It is advanced in the sense that it has increased passive safety features, it is small and smaller, and factory made, etc. But it doesn't have the critical changes to define it as advanced nuclear, which is using different coolants moderators and system designs versus the light water reactor set. A molten salt reactor would be a great example of an advanced Gen four design.

Erik: You mentioned modular designs and I really want to understand that particularly because I actually have a couple of friends who worked as contractors building one of the big old generation nuclear power plants, the Seabrook plant in New Hampshire. And they told me it was the running joke on it. Basically, the whole problem was it was a great big, huge public project with a huge amount of contractor misbehavior. So the joke on the job site was that the day shift is building the plant, the night shift is tearing it down. All the contractors knew there were apparently special rules that if anything wasn't exactly right, you could do it over again, and not be punished for that in the interest of safety. So what they did is they made sure they made every possible mistake, so they could get paid for doing every job 17 times. And it resulted in not really having the kind of quality commitment that all of that spending was intended to, most of it went to waste. I hear about this idea of building nuclear power plants in a

factory someplace where it's a modular unit that somebody built in a factory to very high quality standards, and then it gets shipped already ready to operate and set up on site. And it just sounds to me like a much, much better way to build a nuclear plant. What's going on in that space? How advanced? Is it? How big of a trend is this? And where is it headed from here?

Adam: Yeah, without being too enthusiastic about the question. You know, modular reactors are and factory built reactors are definitely the future. You're 100% right, that, you know, if you want to call it old nuclear, or big existing nuclear. Each of them in the United States and most of Western Europe, we're kind of bespoke construction projects that were fraught with the problems that you highlight. It's not even just that contractors on the job could do and redo things, you know, building up costs. But you also have major time delays because if you're talking about very customized and specific welding processes, for example, there are only a handful of companies in the world, maybe that can do it. And if you need to change or somebody gets busy, or there's a hiccup, you have very few alternatives, which also gives you very little buying power, whatever when you're building up the costs. Those obviously gets solved if your factory built. So how big is the trend? It's very big. I mean, if you're looking at most advanced reactor designs, inherent to what they're doing is that they are to some or full extent, you know, factory built. And, you know, we're going to learn about just how replicatable it is over the coming years because, again, this is not science fiction, or something that we have to incentivize over the next couple of years to happen. Many would be shocked to find that we have several advanced developers in the US who will have first of a kind plants, you know in 2027, 2028, 2029, making it a reality impacting our grids, you know in the short term.

Erik: Tell me a little bit more about the design of these factory built reactors because if I was designing this, I would want to make sure that the process of transporting it from the factory to where it's going to be used, I'd want to have sensors that are measuring the G-loads and forces and so forth. So if it gets broken, that gets reported, and I want every minute of operation for that reactor to be reporting back to the mothership so to speak, you know, communicating over a network, telling the manufacturer its operating conditions, so that somebody both on site can be monitoring it as an operator, but also the manufacturer can be operating.

And I know for example, in aviation, I have some friends that are commercial pilots who tell me that the latest airplanes are totally in communication with the manufacturer. You do something that's out of limits, and not only does your boss find out about it, but the airplane manufacturer finds out that you exceeded the bank angle, or whatever it is that you weren't supposed to do as the pilot, because anything that goes wrong is being communicated back to the manufacturer. Are they doing things like that with these plants and where is this all headed? And is there going to be a point where maybe society should say, wait a minute, if these new things are so much better and safer? Should we be phasing out that old Westinghouse reactor design, getting rid of those old plants and putting these newer better ones in to replace them?

Adam: In a certain way I think this is an unfair question, because you are asking somebody who thinks that the safety systems and other logistics that are on existing nuclear are some of like the most hardened and well monitored assets that are in existence, and kind of the

Fukushima disaster side, which obviously came up earlier, there's a phenomenal safety track record. And a lot of that is owed to the very complicated and very high quality systems that even current nuclear has. So I just want to make that clear. But if you're talking about advanced nuclear, kind of two things to know that most of the business models are not to have XYZ advanced nuclear company be an owner operator of a plant, generally speaking way there is a a licensed design that a utility or commercial end user would purchase from the company. And then there's kind of a long tail services and fuel management business associated with it. So that doesn't answer your question about kind of safety touch points. But generally speaking, utilities or commercial end users are going to be the owner operators. And I believe well I know for a fact that there are an extreme number of sensors, safety protocols, etc, baked into all of these that would make it extremely clear, if you'd had some sort of breaching the integrity of the structure out of the factory. I would just say that I believe the same type of sensors, and data communication exists on the existing reactor fleet today, too, even though I'm not a nuclear operator. So maybe I'm speaking outside of my, you know, I'm getting over my skis here a little bit.

But I want to emphasize that the safety systems are extremely strong today, there are extremely high frequency and high touch data points that you get as a nuclear operator. We have a nuclear engineer on staff, we should bring him on to tell you exactly how it works in the control room. But again, like the public should not believe that these are anything but the most kind of hardened, safe, safest assets out there. And that doesn't mean that they are safe against everything. But when you've had, as Mike pointed out, you know, three accidents, all with very unique explainable reasons for the accidents happening over a 70, almost 70 year history of operation with 450-ish plants operating with the highest capacity factors, power, power and existence uhm context matters.

Erik: Tell me a little bit more about this industry for building nuclear plants or nuclear power generation devices, I guess you could call them which are modular and get built in a factory and center where they get set up is this something where everybody in that business is trying to solve the same problem, they see it the same way and it's sort of like Boeing and Airbus. They both make commercial airliners, there's little differences, but they're basically working on the same technology. Whereas if I look at another industry, like the computer industry for years and years, you know, IBM was focused on the mainframe model and other people were focused on the network model and the network model one out there was a decision to be made there was a play there to decide I want to invest in this class of computer company versus that class. Is that the case here where there's choices to be made as to why one company or there's one approach in the industry towards how to do modular or does everybody see it the same way and it's just a question of competitors trying to be first in this space?

Adam: I don't think the computer model fits exactly. And I don't think the airplane model fits exactly. I think what is underestimated by the general energy investing public about nuclear is that there are many applications that different reactor designs work well for. So I think the average, all of us included, the average person thinks of energy as electricity. But there are many more applications than that, you know, where do we get industrial heat from?

Desalination? Hydrogen production is kind of is a big topic today. Your green hydrogen is all good. But how do you get green hydrogen? And to your question, different reactor designs, even in the modular sphere are better at addressing different pieces of the de-carbonization puzzle. And so they're not all after the same end market. If your question was more geared towards, you know, are they all, you know, kind of building factors in the same way? Are they trying to create the same process to get to the reactor generally? To be honest, I can't give you a straight answer on that. I believe there are best practices being lifted from other industries for mass manufacturing of this type of equipment that are being applied to advanced Modular Reactors. But to be honest, the specifics of that is a little bit outside of my scope, but I would probably, if anybody that was listening, you know, is curious, the technical chief that we have at at Segra would be well equipped to talk through the specifics.

Erik: Let's take a step back down to the problem that we started this conversation with, which is the world is in an energy crisis that most people have not even figured out yet is an energy crisis. Certainly people in Europe have, but they think it's local, and they think it's contained. And they think it's only about Ukraine and in Russia. And I think that they're going to discover, it's really much worse than that. And it's going to be with us for a long time. Now, on the one hand, I'm very delighted to hear you tell me that there's a much better kind of nuclear than the old kind that can be built in modular plants. It all sounds great. But I gotta believe that the lead time for a if we could persuade everybody in the world, just overnight, push a magic button to change their attitude, and their objection to nuclear energy. Still, it sounds to me like it takes 5 to 10 years to build out the plants needed to make a meaningful difference. Am I missing something there? Is there any way to speed things up for nuclear energy to more quickly help to solve what I think is going to be a critical global energy crisis?

Adam: Yeah, there's a lot of a bureaucratic red tape in the regulatory process. A lot of it is good, because the safety standards are extremely high. But there's a lot of talk in the industry about streamlining the NRC process in a way that makes designs more easily approved. But I would also swage some of your fears by saying that, again, I think the general investing public is unaware of the fact that there are several advanced developing designs that are making their way through that process, so that they can impact our grids, economies, etc over the next five years. If we needed something over the next 12 months, that would be difficult.

Erik: Let's suppose that there was a complete change in attitude. And I don't think it'll be complete. But there will be a major change in attitude when people realize that this whole green climate agenda, even if you still love the agenda, it's expensive. It comes at the cost of creating this energy crisis that we're going to have to get through as as a planet somehow. If we have this difficult situation, and we give the green light, so to speak, and just go ahead and fund a bunch of projects and greenlight a bunch of nuclear projects. How long from that decision to actual megawatts going on to the power line? Is it two years, three years, four years? How long does it take?

Mike: Well, it depends where you are. You know, the West, at one point had had great leadership and nuclear power technology and they were able to build but for many years, for

decades now the West has lost leadership and they've lost you know, not many kids go into to become nuclear power reactor designers in the schools, and it's been overtaken by the east. You think about Russia went from 1986 having Chernobyl with a horribly designed reactor to now in the world of nuclear power. The Russians dominate, they dominate enrichment, they dominate conversion, but they are a huge reactor builder and not only for themselves, but They export their updated and more technologically advanced and safe reactors.

And then the Chinese right? The Chinese are building significant amount of reactors. They have 22 reactors under construction right now. And 50, some odd reactors that they're using, and they have plans to build a significant more reaction, I think want to get to 130-140 gigawatts of electricity by 2030, which would be 10s of reactors. They plan on building starting on 8 to 10 reactors per year. So what's the difference between the West and East? Well the Chinese are going to build one. They're going to build one, they say, five years, it's gonna be 5, 6, 7 billion dollars and it gets done under budget, and in less time.

In the West, that's not necessarily the case. But that's, this is a story of growth coming from non-western areas. Now, from an investment perspective. What attracts Adam and what attracts us is and what was not needed, but and I don't want to speak for Adam, he can answer, but that's been additive to the thesis has been that the demand coming from the west, the closures that were slated to occur are not happening. So that alone is going to help people who were who were losing look at Diablo Canyon in California. In other parts of Europe, those reactors that were going to shut or not, that in and of itself help solve part of the crisis because the solutions that that people policymakers thought could be there, they realize now it's not going to work. But right now you have 60 reactors under construction globally, with several each year hitting the grid of one gigawatt reactor, it's going to, you're going to solve electricity problems for three quarters of a million people. So you know that it doesn't solve all the problems? No, but you've got 60 under construction, you've got another 96 reactors globally that are planned and put in a proposal stage, you have over 300 reactors. So five years, the Chinese will build them in five or six years, it's going to cost them you know, like I said, 5, 6, 7 billion dollars. Other countries, you know, the South Koreans build them but the West is starting to ramp up again. But you know, it's it typically what you've seen here so far is a little over budget, a lot over a lot over budget and a lot over time but this is a this is not a Western growth story.

Erik: That concerns me because, you know, I think all three of us, as I understand it are born in the United States, it would probably feel good to all of us to patriotically proclaim that our technology surely must be the best. But frankly, from what I'm hearing sounds to me like this is a Toyota Corolla story that is much as we might have invented a lot of this technology in the United States, it sounds like maybe the Asians are in a better position to create this industry of factory built highly reliable nuclear reactors that they then sell to the west and is that right?

Adam: Well the good news is, yeah, I don't think we have to be that defeatist. I mean, I think Mike is, Mike is 100%, right? The Chinese design which is their first domestic reactor. The Koreans for decades, have been on time and on budget. And on a you know, on an energy equivalent basis, you know, they've been very economical. But there's a common denominator

here that even when they were building, these were not factory built. I don't think Mike was talking about factory built reactors he was talking about conventional large gap, and the reason that they were successful, but using the South Korean and the Chinese example, is because they were replicating the same design and model over and over again. Whereas generalizing a little bit here, by and large in the West, each one of these was a bespoke monster infrastructure project. So whether it's in a factory, or whether it's picking a design and perfecting it and sticking to it, you know, the key is replicatability. And, yes, I think we have lost some of our academic edge in the United States over the last decade or two, as we have led our domestic nuclear industry to window on a relative basis, but it's not too late. And again, if there's a reason to be optimistic, it's that the United States absolutely has the best or I would say North America has the best and leading designs for advanced reactors.

Mike: Yeah and Erik to be clear, I was talking about the older big reactors. And also to Adams point about not being too late. You've just seen in the Inflation Reduction Act. You've seen the biggest boost to US nuclear power in decades. I mean, a significant amount of capital has been committed to them in the form of production tax credits, that basically gives a lifeline to those reactors that were not economically competitive. There's a huge technology inclusion for clean electricity and loan guarantees and all things high assay, low enriched uranium. There's a clean hydrogen credit, which is part of it that they can access. So massive amount of money being committed to nuclear, which is bipartisan and is something you haven't seen here in many decades. And there's been a resurgence, a nuclear renaissance, even if you're not seeing the older reactors being built. But to Adams point in the advanced small modular reactor of space in the advanced nuclear space, there's a massive amount of commitment taking place. What I was talking about is those big one gigawatt reactors around the world and that's where the growth is going.

Adam: We're kind of darting between two topics here, like one, you know, our global energy systems and how we create enough energy for a growing population in the midst of the energy crisis, which is now being exposed. The other is what you need to happen as a series of dominoes to make money as an investor in the broader energy markets, and then maybe specific to Mike, in my discussion in nuclear fuel markets. And that's where rate of change versus you know, kind of final objective becomes so important. And I don't want to divert the conversation Erik if we're going one direction, but I did want to emphasize that the two are very different things. You know, what, in our opinion, sorry, Mike, to lump you in with me, are the conditions to make significant returns investing in the broader nuclear opportunity set, versus what has to happen for nuclear to be the panacea of our energy flows?

Erik: Well, I agree with the two different things great minds think alike for sure, Adam. And I was starting with what does it take to get the world there, but what I want to move to next is let's talk as investors about where the opportunities are in this space, because frankly, I'm having a hard time just getting my head around the very highest level of okay, a guy like Mike focuses on the uranium fuel cycle. Well, that sounds great, because clearly, uranium is the fuel that's going to be used in any nuclear reactors that are being considered today, we'll talk about thorium before we're done. But it's not an immediate consideration. It's a maybe someday story. So if

we're going to focus on uranium is that at all it well, wait a minute, this transition to get from where we are today to the kind of nuclear renaissance that I think we all agree is needed, is going to involve much more investment in building all of the plants than it is going to be in buying fuel, because the fuel is a very small piece of this. So do I make more money as an investor in investing in this industry or in speculating on the price of the fuel or in doing both? How do I weigh those things? What are all the options? Why don't we start with Mike this time since the Adam has been talking a lot. Why is it that you focus on the fuel cycle and not on things like investing in the companies that build Modular Reactors the way that Adam does?

Mike: Sure, and Adam will speak, I don't wanna speak for Adam but their main fund focuses on the fuel cycle as well. They have a new fund that focuses on the small, the advanced nuclear stuff. But I think Adam, I don't want to speak for Adam and, uh, but I would say that when we started out this investment, you know, we're looking for asymmetry and investment. And we're looking at supply and demand, and we're looking at the marginal cost of production. And we're looking at incentive prices. And what was attractive to us about the nuclear space is kind of where this conversation started and where it was going, which is, there's a lot of uncertainty about uranium, right, so about nuclear power, I should say. And so you have to overcome people's fears. Yeah, and these misnomers that are out there. And these, and I said earlier, you know, don't let the narrative get in the way of a good story. So you have to overcome that well, but that also works to an investor's benefit. If an investor is willing to ignore headlines and do a deep dive, research dive, and it's especially beneficial when people have left the building, when after Fukushima, which we talked about. It scared a lot of people and the price of uranium was down 90 some odd percent, the number of companies producing it went from 500, down to less than 40. And most of those were exploration companies. They weren't even producing so the producers were a handful. Wall Street left, they disappeared. There were no more uranium analysts per se, maybe a few but they're at smaller shops. The institutional capital left and so there's a scenario there where perception is such that it's a dead industry.

Mike: When you go in and actually do the math, which I did and my team did and Adam and Art at Segra did. You start to realize that at that time several years ago, growth really didn't even matter, you just needed, not much of a decline. And if you just had stable, stable numbers of reactors, and they were off grid and maybe a little bit of growth, then then the reality was, there was not enough economical supply at the prices there were then going back to, you know, 2015-16-17. You know, the price was $18, $20, $22 a pound of uranium. But back then, you know, you could have said, well, it needs to get to at least $50 to $60 to get higher. Now, for a myriad reasons, which I'm happy to discuss later, it needs to be significantly higher.

But the point was, there was too much supply post-Fukushima. Japan took 54 reactors offline, that was 30% of world's uranium demand. And people were scared, and there was a lot of supply coming into the market, and it was excess supply. And it drove the price down. But like everything, things can overshoot. But because of the recency biases in investors, they were not paying attention to it. Not recognizing the price had to triple just to meet the demand that was going to materialize when these excess inventory started to wear down and started to be drawn down. And you were seeing significant drawdown. So from from why do we focus on the nuclear

fuel cycle is, when I started my fund in the middle part of 2018, I looked at an industry that needed almost no growth, maybe a modicum of growth which I looking at the math, I was pretty sure we would get, and we were going to see more supply cuts that would have to come. And that's what we've seen. And at the time, it was, hey, I think the price of uranium has to at least double. And therefore the leverage in these companies, those equities will move significantly higher over time. And that was with a backdrop of I don't need nuclear to be a growth business. I just need nuclear to survive. And I was pretty sure that it was going to survive.

Fast forward to today, nuclear has gone from not only a business that had no growth to a, what I would argue is a nuclear renaissance, with countries around the world pledging their support those who as I said earlier we're going to close are now saying we're going to maintain, some are adding, and other new countries are getting into it. That just makes the fact that there's not enough economic supply. You know, one of the things I want to point out for listeners, Erik is one of the things you often hear is again, don't let the people don't like to let the facts get in the way of good numbers. Well there's a lot of uranium out there. There's a lot of uranium out there. Absolutely. It's economic and under development to uranium that matters. And there's not enough of that at these prices. So it's all about the incentive price. And so why do we invest in that because I look at it kind of like a picks and shovels play. You know, these reactors are going to work, the next generation reactors I think are going to really catch on, they're going to need in many of them will lead uranium and financial interests because it's coming into the space and they're gonna buy uranium.

So for us, it's that, you know, the price of uranium today sits around $50 a pound in a spot market that is inconsequential. I could happily talk about that I'm sure because I'm talking too long here. But, you know, we think the price needs to at least double from here. And you know, if you look at the last cycle, there was not when the prices started to move significantly, there was not a deficit in the market looking out several years. Today, if you look at it by our math, I won't speak for Segra but we think there's, you know, 30 to 40 million pound per annum structural deficit in the market. So we think prices are headed meaningfully higher and again, that was before any of this Renaissance was starting to take place.

Erik: Now let's bring into this discussion. The other dimension of all this, which is the changing geopolitical climate that we face, as I understand it, most of this industry, especially in the fuel side, is dominated by foreign interests. And particularly, Russia is a major player at one point we got a lot of the fuel for US power plants was actually down blended Soviet era weapons warheads, where they would down blend that back down to the level of enrichment appropriate for a nuclear power source. I guess that program is over because they've used up all of their decommissioned warheads. But we still have a situation where the United States as I understand it doesn't really have uranium independence. We can't both mine the uranium and enrich it and get to nuclear fuel on our own anymore, that industry no longer exists in the United States. I think that the trend that we see now, between Russia, China, and United States kind of becoming more and more adversarial is set to continue. If that does continue, and let's say China and Russia both wanted to conspire to not allow the West to have any more than

necessary if it became a competitive issue, where China and Russia were wanted to deny access to uranium to Western Power Producers? Are they in a position that they could do that?

Mike: Yes, so let's talk about that. We could talk about energy policy in the United States or lack thereof, we could do many shows on that. But let's just take it as energy policy has been a bit of a train wreck here. But if we go back to the height of the Cold War in 1980, the US produced between 40 and 45 million pounds of uranium to consume 50 million pounds of uranium and its reactor fleet 1980. Fast forward to 2022, the US produces basically zero uranium. And it imports a significant portion of that at least 20% comes from Russia, we get some from Uzbekistan, and we get a chunk from Kazakhstan. So the production here, there's no enrichment capabilities that are owned by the United States in the US. And again, as Adam referenced earlier, uranium by itself isn't anything, you got to enrich it. Coming out of the ground, it can't produce power or a bomb, it's got to get enriched. There's a little bit of capacity here in the United States, but it's owned by a Dutch English consortium, called the Ranko. We don't have any of our own here in the United States. So the US because of this whole globalization, because the belief that the Russians were our friends ceded control of the nuclear fuel cycle to the Russians, essentially. The Russians control 41% of enrichment, 30% of conversion, and 14-15% of uranium production. Just a quick 30 seconds on the fuel cycle, it comes out of the ground and they turn into yellowcake it's a powder, it gets converted to a gas called UF6, and then it gets enriched to the levels it needs to produce either power or a bomb. And the Russians have dominated that.

Now, there's a growing awareness, obviously now, right? There's the investing public will look and say, oh are we going to sanction the Russians. Oh, what's going to happen there, if I'm a US nuclear utility, I am going to sleep every night, praying to God, two things. One is, those sanctions don't happen, but to the thing they can't control, because at least they can lobby their way out of that. The thing they can't lobby their way about as if Putin decides not to send fuel here. Now, if you go back to 2019, you'll recall there was a section 232 filing in the United States. And that's when some of the US producers said that on grounds of national security, they wanted the US to have to buy 25% of their uranium from US producers. And the utilities fought that tooth and nail. They didn't care. They were pounding producers were buying the cheapest and the Russians and everyone else is our friends. And they presented a slide in their response to it. That's one of the major utilities said, basically, there is no disadvantage to US utilities, the other guys sell it cheaper, what Cold War? What are you talking about?

You know, I'm on record, I believe Adam and I are. You know, there are always geopolitical risks here in this space, talking about these issues and here we are. So what happens, you know, the US under the Russian suspension agreement can bring in enriched uranium. 20% of their enrichment that can get shut off at any time. They'd have to go scramble to find it. They're trying to work with the enrichment plants to be able to the price of enrichment, the term price of SWU, which bottle separative work unit, which is the unit of enrichment, it went down as low as $35-$40. And here, you're up over triple digits right now and it's really starting to rise rapidly. Because that's Western enrichment capacity that, again, you know, we go back to talking about underinvestment in oil and gas. You know what, it's funny, when people are pounding at your

door and telling you, you're in a bad business, you shouldn't be doing this, or the economics don't make sense, you don't invest. So what happened in the enrichment globally, in the West? They didn't reinvest. When centrifuges were retiring, they didn't put it back in.

Now, fortunately, there's technological abilities within the enrichment plant, even though the physical capacity isn't there. They can extract more enriched product than what they have and they're able to technologically achieve that. But it would require a breaking of the status quo of the past 30 years of a very lackadaisical Western utility environment where they now have to really be creative and have to spend a little bit more money. You also referenced something, the cost of the front end of the fuel cycle is probably 25%. The cost of uranium can be mid-single digits, high single digits, low teens, depending on the price of uranium. Compare that to coal or natural gas, where it's 80 or 90% to operate one of those things. They can get this done. All the power lies with the fact that they have the ability to write checks. They have the balance sheets to write checks, and then they can solve their problems. And so the power resides with the utilities but until on the supply side, the suppliers are not going to bring on new capacity until they're financially incentivized to do so.

Erik: Hang on, because you've left out one key point that's really of interest to me, which is okay, from what you're saying. We've got real issues in terms of what if these supply chains went away, but what it really begs is a question in my mind is what buffers and inventories exist in this industry because if I was running a nuclear power plant, it would seem to me that, you know, the fuel is a very small percentage cost of the overall cost of operation. I would just buy a 50 year supply of fuel rods and, you know, keep mounting the back log just in case I need them. Doesn't work that way apparently, why doesn't it work that way? Help me understand this.

Adam: Yeah. It's a good question, because I can answer it. And it ties into the only point I was going to bring up to supplement what Mike put very eloquently, but inventories should be very, very high in this market. And I think that relatively low inventory levels versus historical in different geographies is a yet another symptom of what we've all been talking about, which is kind of letting the future of nuclear kind of go away. And all of the derivative effects that come from that, including not having much contract coverage out into the future. We're essentially letting global utilities letting their coverage from a delivery of uranium standpoint, dwindle, and drawing on inventories instead of contracting, despite the very low price environment that Mike outlined. So not to go through a history of inventories globally but the Japanese as an island nation, pre-Fukushima, they'd like to have 10 years of inventory on hand, kind of to your point, Erik like why not have just a ton of this? It's a small costs and has immense energy density, which then gives you immense energy security? Why not keep it on hand? Good question they used to. Europe usually runs higher than the United States at maybe three to four years of inventory. And over time, the US has been between two and three years of inventory on hand, so that you always have at least one fuel load reload for our again, a classic Light Water Reactor in the hopper.

Mike and I have spent many late nights wondering why in a period where the forward looking deficits are structural in nature, why that has been the time, like the exact moment when

coverage has dropped and inventory levels have dropped. But this is kind of the exciting part about the bull thesis that we think many misunderstand generalists look at a year or two of inventory and say, well, then I'll worry about this trade in a year or two when they have no other option. And that's just not the way that the nuclear fuel cycle and through a procurement management works at the utility level. In short, inventories are lower than they should be. From our high touch interacting with European utilities in particular. Seeing what's happened in gas this year is totally changing the way that they think about their inventory management going forward. And again, not to be too excited or optimistic about the investment. But we're essentially setting up for a period of time where existing reactors, right those those that have just been operating and were scheduled to operate. We too, are on the cusp of doing their normal replacement contracting. This is kind of the mic jump into but I think this is kind of the the bullseye here.

Existing nuclear plants are on the cusp of replacement contracting that they need. Existing plants that were formerly scheduled to shut down and now I've had to licensed extended need to very quickly procure contracts and inventory. At the same time as advanced nuclear companies are starting their procurement plans over the next two years. And the global utility base needs to go through an inventory restocking cycle. And I think when Mike says he models about a 30 to 40 million pound structural deficit, which is not very dissimilar from our numbers. I can speak for this from the central modeling perspective. That's in our base case where we do not assume inventory builds or competition from advanced nuclear. The market can get very strange from a pricing perspective if all of these factors coalesced at the same time.

Mike: And Erik, you also have this issue of what's called overfeeding, which is it takes place at the enrichment plant but essentially enrichers can use more uranium to enrich it when they have limited capacity which could be a signal you know, you're talking from the delta of underfeeding where they didn't need as much uranium to now overfeeding could be as much as 40 million pounds per annum. So you know, and to wrap a little context around the contracting, the annual contracting coming out of the utilities. And what you've seen this, when you look back many, many, many, many years, is when prices are low, they contract, if I go from the mid 90s to the early 2003-2004 timeframe, let's say. They were contracting, because 85% of this industry ish, 85% ish, is done under 6. 7, 8-10 year contracts. When you look back, when prices were very low, when I'm talking 6, 7, 8 dollars, $10 per pound. The utilities were contracting at about a third of their annual consumption. And that went on year after year, after a year. And they would draw down their inventories. Rather than saying, I've got really low prices, let me go lock it up to your point decades, let me go buy this stuff. They don't. What they do, and it goes back to, you know the, it's a smaller percentage of other sources of, you know, electricity generation coal and natural gas, the uranium itself a small percentage. And then as the prices start moving, when you started to get into 2005 and 2006. By this time, prices move from 7 to 10 to 20 to 30. And then a few series of events happen and people started to get nervous.

Then, all of a sudden, you start to see contracting, taking place at 100, 110, and 120, and 130 and 150% of annual consumption. And then when Fukushima came, and you had Japan come offline, as I mentioned earlier. Now you start to see prices drop, you start to see a number of

mines shut, but you start to see things get or companies go out of business. Now all of a sudden, you start to get into 2011-2012. And you go back to the same 30-35% contract thing. And they start sucking down inventories and sucking down inventories to the point where recency bias, just like last time clicks in just like this time. If you were to go read the surveys that come out of one of the major consulting firms, they survey the field buyers, which is kind of circuitous because they provide the research to the field buyers, and then a few buyers get surveyed by them, and they just regurgitate what they're told. But if you think and you look at those surveys, every single year, they're asked where the price uranium being in this year, and where will it be in five years and almost to the dollar, not quite but close every year to wherever it is that at that point in time. And it's all the way up from 7 to 10 to 15 to 20 to 40 to 60 to 100 and you name it.

And so it all goes back to fuel buyers don't get fired for paying a higher price. Fuel buyers get fired for not having enough uranium. And when they start seeing others start to contracting, then they all run in mass. And to Adams point you're starting to see you had a decade of of only a third of their annual consumption being replaced. UXC, which is the leading industry consultant, who we have had many very nice relationship but we disagree with a lot of their work. But that's fine. That's what makes markets right? But the price has moved up nicely since we started the fund. So we feel as though our work has been in the right direction. But they just came out recently, a couple of weeks ago and said the inventory overhang isn't over. That was the headline of one of their weekly pieces the inventory overhang is over. But yet, the utilities are just starting to now come back to contracting.

And there is an important point to talk about the spot market of uranium. As I said most uranium is purchased over time in a contract market where what determines price are the production economics of available capacity based upon the demand that's required. And when you start matching up. When we talk about deficits are structurally. Consumption equals demand, how much is available? Well, when you start to look at that, and you start to look at how much capacity is out the spot market. After Fukushima, after those pounds were available, you had that glut of inventory that was building up, it made its way into the spot market. And then in 2012-2013, that Goldman Sachs and Deutsche Banks of the world started to come in and they went to utilities very smartly. And said, listen, you typically will sign 7, 8, 10 year deals, whatever your deal is. But there's a lot of inventory out there. We can see that. Why don't you let us use our balance sheet. And why don't you will enter into a carry trade with you. We will do it for one or two years. We'll hold it for you. We'll charge you a fee and then renew the contracts and let's see what it looks like. But we think there's it's going to go down and it did. It went through after Fukushima went from 70 to 62. It peaked at 137 in 2007, but 70 and 60. And every time those one to two year carries were done.

Utilities rehab at lower prices, and it became like a drug for them. And so that was 2012, 13, 14. And then 15, interest rates were very low a cost very little to carry. So you had low interest rates in a surplus market. And the spot market was where these pounds were showing up and physical traders would go into the spot market, buy those pounds, sequester them, and then deliver them when they were needed. They made a little bit of money and the utilities made

money. Well, like everything, supply-demand is starting to suck down a lot of that inventory that started to come into the market. And it got down, it got down, it got down, and then you start to get the prices that were just untenable, you start to see 20. Now, it's about 25% of world's supply has come offline. Those pounds weren't making themselves into their way into the spot market. Maybe, you know, now if we look at it every month, you might see, I don't know a million, million and a half pounds that pop up into the spot market.

Again, out of a market that annual demand. If you look at our numbers, you know, say 200 million pounds plus, so a small amount, but the utilities by buying those carry trades. Were putting off contracting, when I said they were buying a third of their annual consumption. They weren't locking up long term supply. And they were convinced just like they were in the last cycle when uranium was 7, 8, 9 and $10, that uranium wasn't going higher. And well, wouldn't you know it. The complacency led to under contracting. Adam talked earlier about coverage levels, being low, and under contracting leads to one hiccup here, one hiccup there. Oh, by the way, the Russians going in and invading Ukraine. And now all of a sudden the world fuel cycle is geographically changing. And it's bifurcating between East and West. And you're and now you're left looking out like wily coyote over a cliff, where do I get my uranium from, I might not be able to buy it from Russia. I'm not so sure what's going to happen in Uzbekistan, right? Those type of things, it doesn't take much. And now you're starting to see the contracting start to accelerate more. But people stare at the spot market. It's a market that is only a surplus disposal market for a handful of pounds. But there's not a daily mark on the long term contracting. And that's where guys like Adam, and guys, like us believe part of our living in the fuel cycle is where we can generate an ability to understand what's going on. Because those are bilateral discussions that are taking place, it's happening from just chatter in the industry. But there's not a price at the end of the day, the price of the spot price, which is very nothing. It's irrelevant, because utilities look at it. But it's not where you can fulfill long term security of supply for utility.

Erik: Hang on guys, because I want to make sure I understood what you told me and see if I've actually got this straight. You're telling me that at a time in history, when the Cold War was over, and we had a peace dividend, and so forth, it's easy to understand how maybe we wanted to trust people. But look, right now we're at a time in history, where I think tension between the United States and Russia has never been higher at any time, including the Cuban Missile Crisis. We have Vladimir Putin openly and outwardly threatening that if Western sanctions continue on the pace that they have, that the West he feels is risking an escalation to nuclear war. We have at least one sitting United States senator who showed the incredibly poor judgment to publicly make a statement calling for the possibility of first strike nuclear warfare against Russia.

Suddenly, we're in an environment where that's the kind of tension that exists suddenly between East and West. And in that setting with that backdrop, you're telling me that there's guys running these nuclear power plants, who are saying, yeah we could buy some more fuel and keep some in stock. But actually, we read this book about just in time inventory, and we can impress somebody by coming up with two more basis points on our bottom line by not carrying

excessive inventory. And it seems to us like now is a smart time to play that game. Is that what you're telling me?

Mike: That's what we're telling you.

Erik: That is nuts. That is a national security risk that somebody needs to take seriously.

Adam: Far ahead of Russia and Ukraine conflict, Segra and Mike and team were saying the same thing. If you believe in geopolitical volatility, I would put to you or anybody else, to find me a commodity that is more vulnerable than uranium. The consumers of uranium produce almost none of it. The producers of uranium consume almost none of it. The vast majority of production currently are in geographically sensitive areas and you have had two non-western countries, Russia and China as kind of the leaders of the, honestly of the global nuclear industry over the last decade, and have as a result of that focused the most on the fuel cycle relative to other countries.

Erik: If Russia and China jointly decided that they wanted to withhold uranium from the West as a form of economic warfare, are they in a position to do that? And how long would it take before the West ran out of fuel for their nuclear power plants and had to shut them down.

Adam: So neither China nor Russia mine, Russia mines, I believe, around 5% or 6% of the world's raw uranium so it's something. China is essentially in control of a few key assets in Africa, but most of that supply goes directly back home anyway. So it's not fully on the market. But where the real pinch point as Mike pointed out, is in the enrichment sphere, you mentioned that we didn't get a chance to address it. But Erik, you mentioned the megatons to megawatts program, the down blending program, that in and of itself is not the entirety of the influence that Russia has over the nuclear fuel cycle. The US still gets about a quarter of their enriched uranium product from Rosanna. It varies utility to utility, but in aggregate, you're in the 20% range 20% plus range for the US industry. So if it's almost worse than restricting uranium. We would actually be restricting enriched uranium product, which is the second last step before getting it into the reactor, before you fabricate it into your specific fuel rods. So in short, there will be a very, very big impact. And I don't think it's a very big surprise, it went unnoticed.

Mike mentioned the earmark for domestic hairy production in the insulation Reduction Act, probably for a different podcast. But there was a whole lot of lobbying that went on behind the scenes to try and reinvigorate our domestic capability for the fuel supply specifically for Advanced Generation, I believe for this very reason. No doubt, the idea of hard sanctions on Ross, Adam had been floated in the early parts of of the invasion. We very quietly moved past them, I think it would be very difficult in short order to move away from our enrichment exposure in the form of legacy contract deliveries that we have facing us, Adam at the moment.

Mike: Yeah, no, I mean, you know, for us you know, it's an interesting market, as I mentioned earlier, the spot market will move around a little bit and stocks will go up or down based on on where the spot markets moving. But I think because of the the world has changed, and I think

whether or not the Russian-Ukraine happened. There had been under contracting for many, many years, the inventories were running down, and contracting started to occur again, anywhere near consumption levels, the math is just glaring, that there's a significant deficit. So that's, you know from our perspective, where we've made our bets is, you know in those certain uranium mining companies, and certain, you know, development companies and a small handful of exploration companies.

Erik: Hang on, let me just make sure I understood that statement, you're saying the reason that you focus on their uranium fuel cycle and the price of uranium, rather than on trying to make money on the companies that build the plants and so forth, is that you see this as such a perfect setup where most people don't understand it. There's plenty of room for a really big, you know, rubber band snap kind of move to happen in uranium, and you want to be ready for it. And that's why you give the fuel rather than building the plants and the other things that go into this the investment focus, is that right?

Mike: Right, just because I you know, we think the plants are necessary it within our timeframe, you know, a few years, the price for the lights to stay on. I don't mean, to make light of it, but for the price needs to go higher. And to incentivize the production that is required to meet the security of supply of utilities around the world is simply the incentive price needs to go up. And it needs to go up meaningfully. And it's come from you know, 18 to 48 to 50 wherever it is. The opportunity continues to evolve as people stare at spot price, not recognizing the transition has occurred. Now we believe towards production economics and the long term contracting cycle. And as a result, that's where we are as investing our money is in those companies that would benefit from that. Now, we also think there's significant opportunity in the building side. That's what Adam and Arthur do with the SMRs. But, you know, they're expressing their view by starting a vehicle there. We just haven't done that. But we think there's great opportunity there.

Erik: So it sounds like you both agree that the best opportunities are in the fuel cycle, because that's where the variant perception is where you see something that the rest of the world has not really picked up on very well yet. But in Adams case, he's also offering fund offerings, which go beyond that and get into the other areas as well.

Adam: Yeah and they are major inefficiencies in the other areas to major. It's almost like asking, which of your kids do you like better. Different drivers of investment returns tied to the same thesis, but much of the information asymmetry is we like to say that exists in the fuel cycle and the public markets opportunities related to nuclear also applied to the private markets. There is a lack of investor understanding there's an unwillingness to lead rounds, there is honestly a informational gap in terms of understanding the technology, timelines, regulatory process, all of the kinds of roadblocks that we as investors with expertise like to have is a differentiating factor for our work.

Erik: Now, there's another aspect to this story, which I'm not sure if it's relevant or not, but I know a lot of our listeners are interested in it, which is this question of thorium. There's one

fellow named Kirk Sorensen, an ex-NASA engineer, who claims that there's a better way to build nuclear power plants, not using uranium, but using thorium instead. Something I've heard very consistently from everybody I've talked to is whether he's right, wrong, or indifferent. The fact of the matter is the whole industry and all of the regulators that government are only set up to allow uranium fueled nuclear. So I guess in the amount of time that we have in this interview, I just like to understand for both of you, is this whole thorium thing? Is that the way of the future and where it's all headed, or is that just kind of a crazy out there idea? Should we be looking seriously at thorium replacing uranium someday? Is that just kind of pie in the sky stuff?

I'll take a quick stab, you know, one, there is merit to the idea of using thorium as a fuel, from a science perspective and on a spreadsheet. On an impact timeline, which is a lot of what this podcast has focused on this discussion has focused on, we do not see it as likely impacting your markets under the timeline, which we all believe we kind of have a critical need. As soon as you start getting into the thorium realm, you know, why not discuss fusion or any of the other further down the road, scientific developments in the energy sphere that that may help address some of the problems that you just mentioned. But most important, if I wanted to leave everybody with kind of one thought, it's that fusion both in current form, and certainly an advanced form works. It works well. It's well understood. It's safe and getting safer. And so it's really about impact, energy security, and maybe even to a lesser extent de-carbonization where we have something good staring us in the face. And I don't think there's any need to reinvent the wheel just to innovate.

Mike: And there's no cycle for it. There's no fuel cycle for thorium. You know, the Chinese are working on model reactor that that is it was a two megawatt test reactor megawatts, right. And think about that then if by 2030 it works. So you're talking a couple of 100 megawatts by 2030. Then they have another type that they're working on that could come around by 2040. So think about this to a couple of 100 megawatts. 1000 megawatts is one gigawatt, the world has roughly, you know, 400 gigawatts of nuclear power. You're talking, you know, thinking in the nuclear R&D world a year is decades, right? So you then have, you'd need to put the financial incentive in place to build these how many hundreds of billions of dollars would that be?

You know, is there a case? Well yeah, like Adam said, but it's just not in any realistic timeline. But we see this Erik, you see this in the energy world, right? It's always everyone saying how bad the other one is why you have to use ours. There is a nice complement for everything... Thorium is way off. But you know, that you never say never to any of these things. But for investors who are listening and want to make, you know, try it trying to make money. You know, Adam said if fission is here now and it's got public support right now, or at least more than it has been a long time.

Adam: Yeah and you're not going to shut down a 60 to 100 years. Let's even say in the magical world and 15 years with thorium start scaling. I still find it very hard to believe that anyone is going to prematurely shutdown large, safe functioning reactors that run off of uranium. So we're still talking about decades and decades of transition. You know, even in the event that thorium or fusion, or something else serves as a better alternative.

Erik: Okay, so it sounds like thorium reactors just like deep geothermal that my friend Robert Friedland likes to talk about great ideas that are not proven to be ready for primetime yet. I should continue to follow them because they're intellectually fascinating. But if I want to make money here, and now today, in the energy market, I should focus in the nuclear space, at least on uranium fired, particularly the modular plants. But really, you guys think the fuel cycle is the way to play this more so than the various peripheral industries. And that's what both of your primary funds focus on.

I know that a lot of our listeners are going to want to know more about that, because we do have a very large, both institutional and accredited retail investor base who are qualified to invest in hedge funds and other things that are restricted to qualified purchasers and accredited investors. So please, why don't we start with Mike Alkin, tell us about what your fund does, and how our institutional and accredited investors should get in touch with you. And also, if there's anything that. If you could eat in addition to pitching your own funds, tell us where people can learn more, whether it's reading a book, or, you know, what's the best way to learn more about this whole nuclear space? I think it's going to be really important in coming years. Mike, let's start with you.

Mike: Yeah Erik if anyone's interested, go to our website sachemcovepartners.com. It will take you to Lloyd Harbor Capital, which is the manager of our fund just the structure how we're set up. And you can you can reach out through there and contact my partner Tim Rotolo, who handles the investor conversations. You know, in terms of terms of the reading, it's really, you know, you gotta be careful, right. So there are a lot of companies out there with glossy presentations that tell you how they could bring uranium on at really cheaply. And it's a bunch of nonsense, you know, they're looking to raise capital most of the time. So you gotta be careful on that, you know, buyer beware, do your due diligence. But there are some very good reference sources. The World Nuclear Association, the Nuclear Energy Institute, it's very dense, laborious reading. You can go and read the balance sheets of utilities to try and understand, you know, how much fuel they have sitting there in inventories, right. Nothing's tied into Bo really in this industry. The consultants are hidden behind paywalls. There's very few sell side analysts, although there are some more that are growing. But it's you know, you can cobble it together, you can put what you can do a list of how many reactors there are, how much output is there and how many mines there are. You know, that's something that we've done over the last several years and as have Art and Adam. But it's really that's it's really grunt work right. But, that's where you know, I think the ability to generate alpha comes from, is by doing work that maybe some others don't want to do.

Erik: Adam, tell us about your fund, what you invest in and how people can contact you.

Adam: Yes, so our hedge fund that was similar to Mike. I would direct you to our website, Segracapital.com. There's a contact form there. Also, on our website, we have a commentary section, where you can read. We do write a lot, some are just for our limited partners, but a lot we also share in the public domain. And so you can see us there. So you can contact us for

either our public markets hedge fund, or the soon to be launched venture fund depending on your interest. And I just want to say again, it's, you know, I am completely aligned with Mike, we are more excited, I think about fuel cycle related investments, you know, loud and probably anytime, including when Uranium was $18. And we launched the strategy just because of how much misperception there is in the market versus what we think is a forward looking trajectory of things. But I wouldn't say necessarily, that it is better over time than what we also see in the advanced nuclear space. Again, I can't tell you which of my children I like better, each has unique drivers. Both are tied to the idea that nuclear is not going away. And I would just urge anybody that's interested in our views to ask us to follow up and we can kind of walk through the drivers of each investment, the drivers of each investment in more detail.

Erik: Gentlemen, I cannot thank both of you enough for a terrific interview. We're going to leave it there for this week's show. Listeners, Patrick Ceresna and I will be back next week. We'll actually be changing our existing show format then as well. So we've got some more exciting stuff in the pipeline for you. We'll see you again next week.